Technical Support Document

Analysis in Support of the Clean Air Interstate Rule Using the Integrated Planing Model

U.S. Environmental Protection Agency
Clean Air Markets Division
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Table of Contents

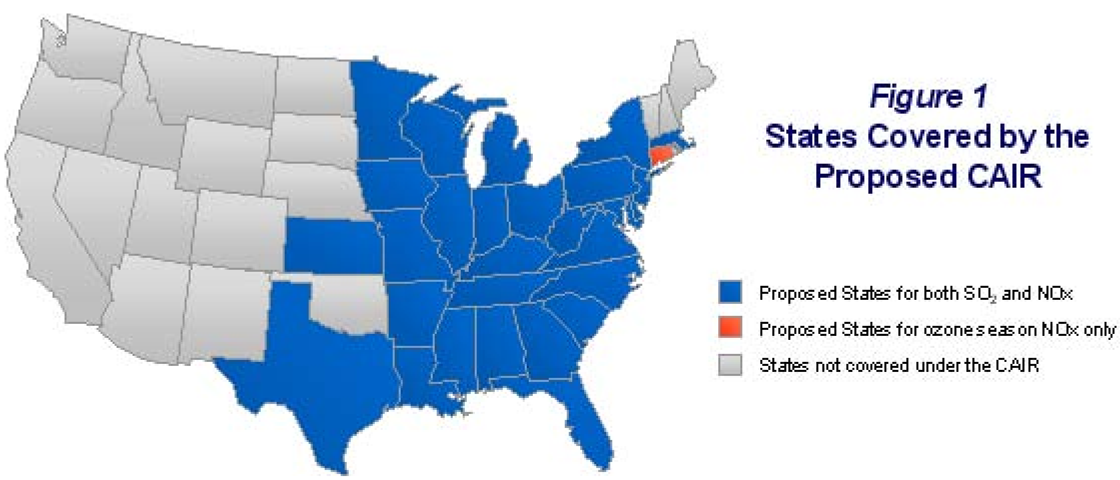
A. Overview

This document summarizes additional analysis that EPA has performed related to the January 30, 2004 proposal to reduce emissions of sulfur dioxides (SO_2) and nitrogen oxides (NOx) that contribute to downwind non-attainment (69 FR 4566). More specifically, EPA used the Integrated Planning Model to assess the impacts of the proposed reductions in the geographic area proposed in the January, 2004 notice using the NOx emissions cap and a close approximation of the SO2 cap proposed for the CAIR (see Section D of this document).

The Integrated Planning Model (IPM), developed by ICF Consulting, is a dynamic linear programming model that can be used to examine air pollution control policies for various pollutants throughout the contiguous U.S. for the entire power system. Documentation for IPM can be found at www.epa.gov/airmarkets/epa-ipm.

B. Background

On January 30, 2004, EPA proposed emission reduction requirements on 29 States and the District of Columbia. Those emission reduction requirements were based on achieving highly cost-effective emission reductions from large electricity generating units.



While EPA believes that the modeling it performed for the January, 2004 proposal provided a reasonable estimate of the impact of requiring highly cost-effective emission reductions from electricity generating units, it did not exactly model the proposed control region. For both SO_2 and NOx, EPA had used modeling that differed slightly from the proposed January, 2004 proposal control strategy, otherwise known as the Clean Air Interstate Rule (CAIR)[1]. For SO_2 in particular, EPA modeled the program assuming a cap on national emissions rather than in the 29 States proposed. Although the modeling done at that time provided a very reasonable approximation of the impacts of the original CAIR, EPA has completed additional analysis. This additional analysis examines the effect of covering the geographic region proposed in the January 30, 2004 proposal using the NOx emissions cap and a close approximation of the SO2 cap proposed for the CAIR (see Section D of this document).

C. Proposed Control Strategy Analysis

For SO_2, EPA proposed that 28 States and the District of Columbia must reduce emissions of SO_2. Modeling done for the original CAIR proposal applied a cap on emissions of SO_2 on all 48 contiguous States and the District of Columbia. EPA believed that this was a reasonable approximation of the proposed program, because 92% of the SO_2 emissions in the 48 contiguous States occur in the 28 States that were covered by the proposal.

For NOx, EPA proposed an annual cap on 28 States and the District of Columbia and an ozone season only cap on the State of Connecticut. In its modeling for the original proposal, EPA modeled a NOx cap on a slightly different region[2].

For the supplemental proposal, EPA has performed refined modeling of the emission reduction requirements proposed on January 30, 2004. In this refined modeling, EPA modeled the exact control regions for both SO_2 and NOx, as proposed[3].

1. Emissions

For the proposed control region as a whole, the results were very consistent with modeling done for the NPR. Table 1 compares the emissions from the two modeling runs.

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[1]The January, 2004 proposal was formerly known as the Interstate Air Quality Rule (IAQR).

[2]The NOx region modeled for the January, 2004 proposal included Minnesota, Iowa, Missouri, Arkansas, and the Eastern half of Texas along I-35, and all States to the east of these States.

[3]The CAIR proposal includes Connecticut in the program for NOx only, and allows the State to control either during the ozone season, or annually if the State wishes to participate in the CAIR NOx trading program. The modeling done for this analysis incorporates Connecticut with an ozone season NOx cap only, and does not allow trading with CAIR States. If Connecticut chose to participate in the annual program for NOx, the total and marginal costs of the CAIR would likely be slightly less than presented in this analysis.

Table 1 SO_2 and NOx Emissions from the Electric Power Sector Under the Base Case and with CAIR								
		2002 Emissions	Base Case		Original CAIR Modeling		Updated CAIR Modeling	
			2010	2015	2010	2015	2010	2015
Emissions in the Affected Region (million tons)	SO_2	9.4	9.0	8.3	5.3	4.6	5.0	4.5
	NOx*	3.7	3.1	3.2	1.6	1.3	1.6	1.3

*Note: Excludes Connecticut

While the results within the control region were consistent, the refined modeling run, which does not cap SO_2 in the States that were not affected in the January 30, 2004 proposed rule, provides a better forecast of the potential impact on those States not covered by the rulemaking, assuming that additional requirements are not placed upon units in those States. Modeling indicates that two States, North and South Dakota, would increase emissions of SO_2 with the CAIR above what they would have emitted in the absence of the rule, although the increases are relatively small in magnitude. In 2015, North Dakota is projected to increase emissions of SO_2 by roughly 20,000 tons (12% increase) and South Dakota by 10,000 tons (24% increase), above what they would have emitted in the absence of the CAIR. The increase in SO_2 for these two States represents less than 0.6% of projected nationwide SO_2 emissions in 2015 under the CAIR proposal. Electricity generating units in these two border states, in the absence of any other limitation on their emissions of SO_2 other than Title IV, are able to provide power at lower cost than electricity generating units in the CAIR region and increase their utilization in order to meet regional electric demand at the lowest cost. EPA's modeling did not assume future requirements, such as BART, that have not yet been finalized. Since there are a number of BART affected electricity generating units in both North Dakota and South Dakota, inclusion of BART requirements for these units would significantly lower SO_2 emissions in these two States.

2. Projected Costs

For the January, 2004 proposal, EPA projected the annualized incremental cost for the region to be \$2.9 billion in 2010 and \$3.7 billion in 2015. Regional costs with more recent modeling are projected to be \$4.2 billion in 2015. The marginal costs of reductions are also consistent with newer modeling, as shown in Table 2.

Table 2 Marginal Costs of CAIR With Original and Updated Modeling					
		Original CAIR Modeling		Updated CAIR Modeling	
		2010	2015	2010	2015
Marginal Cost ($/ton)	SO_2	$700	$1,000	$800	$1,000
	NOx*	$1,300	$1,500	$1,300	$1,500

Source: Estimates derived from the Integrated Planning Model.

3. Projected Control Technology Retrofits

The original proposal was projected to require the installation of an additional 63 GW of flue gas desulfurization (scrubbers) on existing capacity for SO_2 control and an additional 46 GW of selective catalytic reduction (SCR) on existing capacity for NOx control by 2015. Updated modeling projects 67 GW of scrubbers and 53 GW of SCR by 2015 (see Table 3).

Table 3 Pollution Control Installations by Technology with the Base Case (No Further Controls) and with the Proposed CAIR in 2015 *(GW)*			
Technology	Base Case Total (Cumulative)	Incremental with Original CAIR Modeling	Incremental with Updated CAIR Modeling
Scrubbers	120	63	67
SCR	125	46	53

Note: Base Case includes existing scrubbers and SCR as well as additional retrofits for the Title IV Acid Rain Program, the NOx SIP call, NSR settlements, and various State rules.
Source: Integrated Planning Model.

4. Projected Generation Mix

Table 4 shows the generation mix under the original CAIR modeling along with revised modeling. Coal-fired generation and natural gas-fired generation do not change significantly under EPA's updated modeling.

Table 4
National Generation Mix with the Base Case (No Further Controls) and the Proposed CAIR for the Original and Updated Modeling
(Thousand GWhs)

Generating Fuel Use	2010			2015			2020		
	Base Case	Original CAIR Modeling	Updated CAIR Modeling	Base Case	Original CAIR Modeling	Updated CAIR Modeling	Base Case	Original CAIR Modeling	Updated CAIR Modeling
Coal	2,165	2,139	2,141	2,20	2,172	2,170	2,237	2,172	2,171
Oil/Natural Gas	851	876	873	1,12	1,155	1,157	1,439	1,503	1,505
Other	1,180	1,179	1,179	1,17	1,179	1,179	1,176	1,175	1,176

Source: Integrated Planning Model.

5. Projected Coal Production for the Electric Power Sector

Coal production for electricity generation is practically unchanged in updated CAIR modeling (Table 5). The reductions in emissions from the power sector will be met through the installation of pollution controls for SO_2 and NOx removal. The pollution controls can achieve up to a 95% SO_2 removal rate, which allows industry to rely more heavily on local bituminous coal in the Eastern and Central parts of the country which has a higher sulfur content and is less expensive to transport than Western subbituminous coal.

Table 5
Coal Production for the Electric Power Sector in 2000, with the Base Case (No Further Controls), and with the Proposed CAIR for the Original and Updated Modeling
(Million Tons)

Supply Area	*2000*	Base Case			Original CAIR Modeling			Updated CAIR Modeling		
		2010	2015	2020	2010	2015	2020	2010	2015	2020
Appalachia	*299*	318	306	286	312	313	307	314	312	307
Interior	*131*	177	174	189	198	203	229	202	215	233
West	*475*	535	571	594	505	516	488	500	504	483
National	*905*	1,029	1,051	1,070	1,015	1,031	1,024	1,016	1,031	1,024

Source: Integrated Planning Model.

6. Projected Retail Electricity Prices

Retail electricity prices for the CAIR region are projected to increase a small amount with the proposed CAIR (Table 6). A cap-and-trade approach, as proposed in the CAIR, allows industry to meet the requirements of the CAIR in the most cost-effective manner, thereby minimizing the costs passed on to consumers. Regional retail electricity prices are projected to be 2-3% higher with the CAIR.

Table 6
Projected Regional Retail Electricity Prices with the Base Case (No Further Controls) and with the Proposed CAIR
(Mills/kWh, $1999)

Year	Base Case	Original CAIR Modeling	Percent Change	Updated CAIR Modeling	Percent Change
2010	56.8	58.0	2.2%	58.2	2.6%
2015	59.7	61.7	3.3%	61.7	3.4%
2020	61.5	62.8	2.1%	62.8	2.2%

Source: Retail Electricity Price Model.

Retail electricity prices by NERC region are in Table 7, and show small increases in retail prices for the NERC regions in the Eastern part of the country. New modeling is consistent with the original modeling done for the CAIR. By 2020, nationwide retail electricity prices are projected to be less than 2% higher with the proposed CAIR.

Table 7
Retail Electricity Prices by NERC Region with the Base Case (No Further Controls) and with the Original CAIR
(Mills/kWh, $1999)

			Base Case			Original CAIR			Updated CAIR		
Power Region	*Primary States Included*	*2000*	2010	2015	2020	2010	2015	2020	2010	2015	2020
ECAR	OH, MI, IN, KY, WV, PA	*57.4*	51.2	55.0	56.6	53.4	58.6	58.8	53.6	58.7	58.8
ERCOT	TX	*65.1*	54.4	64.5	66.3	54.7	65.1	66.8	55.1	65.0	66.8
MAAC	PA, NJ, MD, DC, DE	*80.4*	58.5	67.5	74.1	60.3	70.2	75.4	60.4	69.7	75.1
MAIN	IL, MO, WI	*61.2*	53.0	57.2	62.6	54.6	60.7	64.1	54.8	60.8	64.3
MAPP	MN, IA, SD, ND, NE	*57.4*	54.5	50.9	49.0	55.4	51.9	49.8	54.9	51.4	49.7
NY	NY	*104.3*	80.4	87.9	90.8	82.0	89.9	91.0	82.1	89.6	90.4
NE	VT, NH, ME, MA, CT, RI	*89.9*	71.8	77.8	84.1	72.7	79.7	84.3	74.2	81.0	84.5
FRCC	FL	*67.9*	71.1	70.2	68.6	72.2	71.2	69.8	72.3	71.2	69.8
STV	VA, NC, SC, GA, AL, MS, TN, AR, LA	*59.3*	55.8	54.7	54.7	56.5	55.7	56.0	56.7	55.9	56.2
SPP	KS, OK, MO	*59.3*	51.7	53.0	56.4	52.5	53.7	57.0	52.7	54.2	57.4
PNW	WA, OR, ID	*45.9*	50.2	49.1	48.6	50.5	49.3	48.7	50.5	49.3	48.6
RM	MT, WY, CO, UT, NM, AZ, NV, ID	*64.1*	62.9	64.4	65.5	63.5	64.6	65.8	63.6	64.6	66.0
CALI	CA	*94.7*	96.0	97.0	97.5	96.5	97.2	97.8	96.5	97.3	97.8
National	Contiguous Lower 48 States	*66.0*	59.5	62.2	63.9	60.6	63.8	65.0	60.8	63.9	65.1

Source: Retail Electricity Price Model. 2000 prices are from EIA's AEO 2003.

7. Projected Fuel Price Impacts

The impacts of the CAIR on coal and natural gas prices before shipment with new modeling are in Table 8, and do not vary greatly with the original CAIR modeling. The increase in coal prices is a result of a shift towards higher priced mine mouth coal and not from increases in actual coal supply region costs.

Table 8
Average Coal Mine Mouth and Henry Hub Natural Gas Prices with the Base Case (No Further Controls) and with the Proposed CAIR
(1999$/mmBtu)

Fuel	*2000*	Base Case			Original CAIR Modeling			Updated CAIR Modeling		
		2010	2015	2020	2010	2015	2020	2010	2015	2020
Coal	*0.80*	0.60	0.57	0.55	0.61	0.58	0.57	0.62	0.59	0.57
Natural Gas	*4.15*	2.97	2.96	2.87	3.06	3.00	2.92	3.06	3.01	2.92

Note: Prices for various coals are not increasing, but the mix is changing towards coals that have higher mine mouth prices.
Source: Integrated Planning Model. 2000 coal and natural gas data is from Platts COALdat and GASdat.

D. Limitations of Analysis

EPA's modeling is based on its best judgement for various input assumptions that are uncertain, particularly assumptions for future fuel prices and electricity demand growth. In addition, modeling using IPM does not take into account the potential for advancements in the capabilities of pollution control technologies for SO_2 and NOx removal as well as reductions in their costs over time. Cap-and-trade regulation that provides clear market-based incentives for reductions serves to promote innovation and the development of new technologies.

The CAIR SNPR proposed two alternatives for how the SO_2 reduction target would be achieved. The proposal took comment on implementing the reduction requirements in the second phase either by using a 2.86 to 1 ratio (which would match the 65% reduction target) of acid rain allowances to emissions, or alternatively, by implementing the reductions using a 3 to 1 ratio (for administrative simplicity) and then letting States create and distribute additional allowances equal to the surplus created by the 3 to 1 ratio to achieve the proposed 65% reduction. In either case, the effective cap on SO_2 emissions from the power sector would be the same. In the analysis for the proposed control strategy described in this document, the model assumed a 3 to 1 retirement ratio of 2015 and beyond Title IV allowances to implement the reductions in the proposed control region, but did not increase the cap by the 130,000 tons of over compliance that would result from this ratio. Therefore, in this modeling, EPA analyzed slightly greater emission reductions than required by the proposal. This assumption was made for modeling simplicity and should result in a slight overestimate of costs for the proposal and of the emissions reductions achieved.

EPA did not incorporate any BART modeling in this analysis. BART stands for best achievable retrofit technology, and the BART rule which EPA has proposed requires facility specific controls on affected units to improve visibility. BART would achieve reductions in non-CAIR States and would likely mitigate any leakage issues, particularly related to the emissions increases in the Dakota's that was pointed out in this analysis.

As configured, the IPM model also does not take into account demand response (i.e., consumer reaction to electricity prices). The increased retail electricity prices shown on Tables 5 and 6 would prompt end-users to curtail (to some extent) their use of electricity and encourage them to use substitutes[4]. The response would lessen the demand for electricity, lowering electricity prices and reducing generation and emissions.

EPA's latest update of IPM was completed in March of 2003, and does not incorporate any State rules or regulations adopted after that date.

E. Significant Energy Impact

According to *Executive Order 13211: Actions that Significantly Affect Energy Supply, Distribution, or Use*, this proposed rule is significant because it has a greater than a 1% impact on the cost of electricity production and it results in the retirement of greater than 500 MW of coal-fired generation.

Several aspects of the proposed CAIR proposal are designed to minimize the impact on energy production. First, EPA has proposed a centralized trading program rather than the use of command and control regulations. Second, EPA has proposed compliance deadlines cognizant of the impact that those deadlines have on electricity production. Both of these aspects of the proposed CAIR proposal reduce the impact of the proposal on the electricity sector.

F. Appendix

1. Integrated Planning Model Run Used in the Analysis

The data presented in this technical support document is from the IPM run EPA216_CAIR_SNPR.

[4] The degree of substitution/curtailment depends on the price elasticity of electricity.

2. Projected State by State Emissions Data (2015) for the Updated Modeling of the Proposed Control Strategy with Interstate Trading

	Base Case		CAIR	
2015	SO_2 Emissions	NOx Emissions	SO_2 Emissions	NOx Emissions
CAIR Affected States				
Alabama	415.99	128.56	295.50	59.49
Arkansas	122.67	52.78	77.93	8.56
Connecticut	6.28	5.23	6.28	5.57
Delaware	48.27	10.84	34.57	9.09
District Of Columbia	0.00	0.08	0.00	0.08
Florida	230.29	170.52	173.80	54.07
Georgia	600.28	153.28	142.97	48.82
Illinois	534.18	178.49	240.27	94.97
Indiana	522.91	241.98	329.21	73.94
Iowa	160.03	86.63	146.03	35.32
Kansas	65.32	101.89	55.61	25.09
Kentucky	357.06	198.71	271.51	52.88
Louisiana	112.53	50.14	94.29	15.36
Maryland	229.58	61.93	39.59	24.58
Massachusetts	16.26	11.87	4.45	13.16
Michigan	384.38	126.09	378.92	94.47
Minnesota	86.67	104.66	74.09	42.58
Mississippi	73.47	44.90	29.18	13.98
Missouri	307.14	140.79	255.66	68.18
New Jersey	38.23	30.35	20.10	13.95
New York	197.41	65.53	100.82	54.41
North Carolina	141.27	62.36	141.27	51.20
Ohio	1025.23	255.93	268.69	93.21
Pennsylvania	805.55	212.90	168.15	79.91
South Carolina	195.54	66.24	145.25	30.81
Tennessee	309.63	102.71	192.43	31.60
Texas	487.07	200.31	349.00	118.78
Virginia	184.74	57.32	114.72	32.98
West Virginia	485.12	148.24	140.59	35.67
Wisconsin	175.74	97.42	167.88	55.32
Total	8318.84	3168.66	4458.79	1338.05
Non CAIR States				
Arizona	47.78	86.04	47.78	85.68
California	10.71	17.81	10.71	17.79
Colorado	70.37	81.02	70.37	81.01
Idaho	0.00	1.16	0.00	1.16
Maine	2.61	1.89	2.61	1.89
Montana	17.72	38.55	17.92	38.55
Nebraska	96.33	56.59	96.57	56.85
Nevada	17.31	40.74	17.94	42.19
New Hampshire	7.29	3.81	7.29	3.85
New Mexico	48.22	76.12	48.22	76.15
North Dakota	171.22	80.18	192.38	85.30
Oklahoma	133.01	86.63	133.01	86.69
Oregon	15.19	13.49	15.19	13.49

Rhode Island	0.00	1.99	0.00	1.65
South Dakota	41.46	12.30	51.21	15.19
Utah	31.38	69.23	31.38	69.23
Vermont	0.00	0.00	0.00	0.00
Washington	5.36	25.47	5.36	25.34
Wyoming	45.99	88.97	45.99	88.97
Total	761.95	781.97	793.94	790.98
Nationwide Total	9080.79	3950.63	5252.73	2129.03

Note: Connecticut was modeled with a summertime NOx Constraint only, and was not included in the CAIR for SO_2.
Source: Integrated Planning Model